Soil Survey in the Bayview Neighbourhood Adjacent to Essar Steel Algoma Incorporated, Sault Ste. Marie, Ontario (2013)

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Table of Contents

1.0 Introduction

Essar Steel Algoma Incorporated (Essar Steel or the steel works) is a fully integrated steel producer located on the St. Mary's River in Sault Ste. Marie, Ontario. Essar Steel is currently the second largest steel producer in Canada, with production of about 2.8 million tons of steel per year (www.Algoma.com). The primary steel making facility includes two blast furnaces, three coke batteries (ovens), and two basic oxygen furnaces.

Air emissions from Essar Steel include particulate, sulphur and nitrogen compounds, and polycyclic aromatic hydrocarbons (PAHs). In recent years, Essar Steel has installed a new baghouse to capture blast furnace emissions, improved the coke ovens to reduce coke oven emissions, constructed a new cogeneration facility to use blast furnace and coke oven gases, and implemented measures to reduce road dust around the facility. Nevertheless, the Ontario Ministry of the Environment and Climate Change's (MOECC or Ministry) air quality criteria for the PAH benzo(a)pyrene (Ontario Regulation 419, Schedule 6) is often exceeded at a nearby air monitoring station located on Wallace Terrace.

The Ministry's Terrestrial Assessment Unit (TAU) (formerly the Phytotoxicology unit) conducted tree foliage and/or surface soil surveys in Sault Ste. Marie in 1998, 2002, 2005, 2009, and 2012 (MOE 2000, MOE 2003, MOE 2006, MOE 2010, MOE 2013). In the 1998 survey, both tree foliage and soil samples were collected at 20 sites located at varying distances (300 to 3,800 metres) in a west northwest to south southeast arc around the Algoma Steel (now Essar Steel Algoma Inc.) coke ovens (MOE, 2000). Only one tree foliage site had PAH concentrations above trace levels in 1998 and this site was located on Bonney Street in the Bayview neighbourhood, close to the coke ovens. Soil samples collected adjacent to the sampled tree had elevated PAH concentrations, with benzo (a) pyrene (BaP) concentrations measured at 1100 ng/g (MOE, 2000). Subsequent TAU soil and vegetation surveys focused on the Bayview neighbourhood..

The TAU's 2002 soil survey report concluded that although Algoma Steel's (now Essar Steel Algoma Inc.) coke ovens were a known source of PAHs to air, there was no apparent gradient of decreasing PAH concentrations with increasing distance from the steel works, and therefore it was not possible to separate the coke oven contribution to soil PAH concentrations from that of other potential PAH sources in the urban environment.

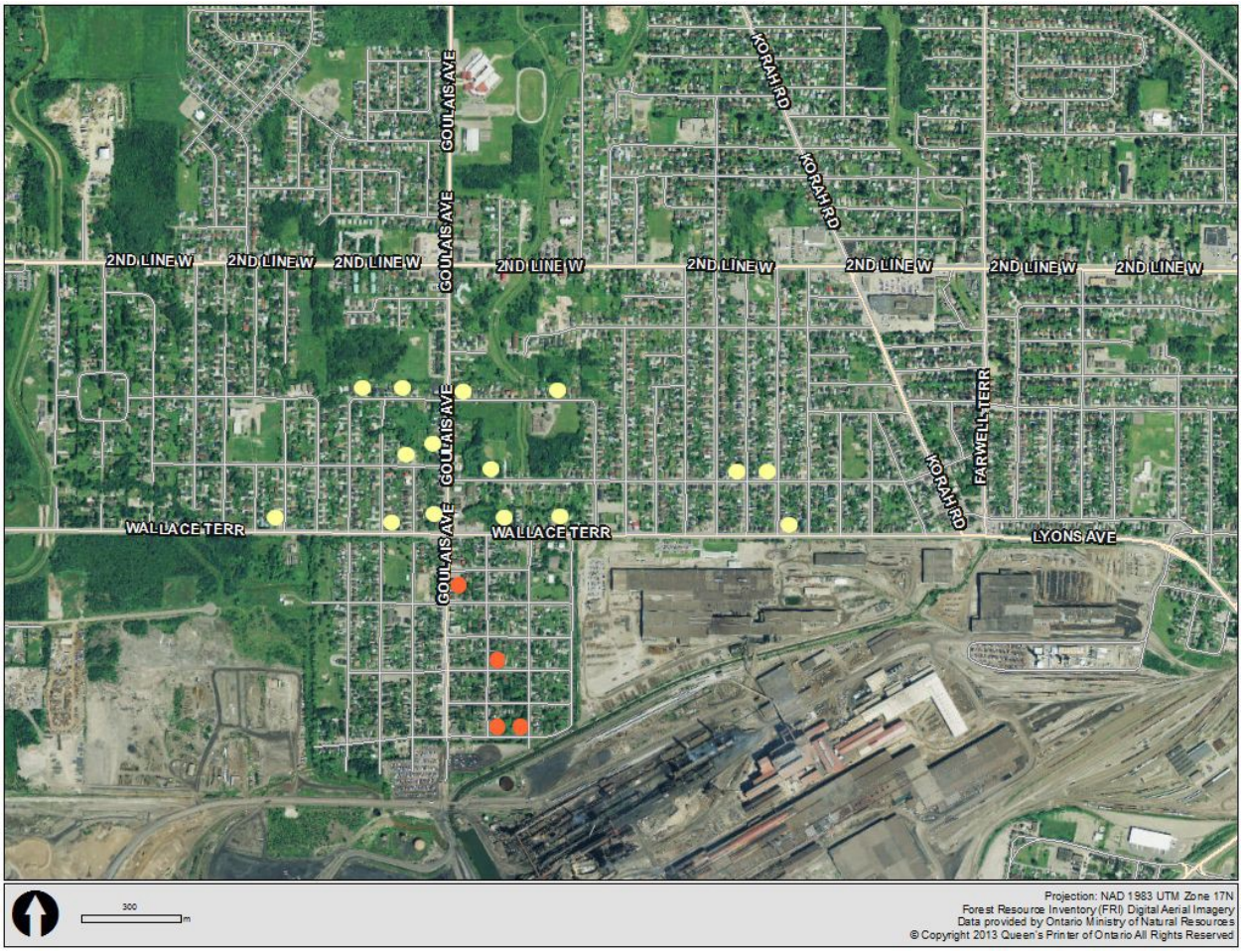
In the TAU's 2005 tree foliage survey, it was concluded that there was a PAH source in the vicinity of the steel facility and that PAH concentrations in surface soil were higher than background concentrations. As part of this survey, three locations were sampled to a depth of 30cm and the results showed a pattern of increasing soil PAH concentrations with soil depth. This was attributed to the migration of particulates containing PAHs down the soil profile. High PAH soil concentrations at one site were attributed to contaminated fill material.

The TAU's 2009 soil survey results were consistent with the 2005 soil survey results. PAH concentrations in surface soil (0-2.5cm) exceeded the Ministry's background-based soil quality standards at all sample sites and exceeded the Ministry's effects-based standards at two sites

(MOE, 2010). Three properties were sampled to a depth of 30 cm and at two of the three properties there was a pattern of increasing PAH concentrations with sampling depth. Although the reason for this apparent PAH contamination at depth was not known, the report suggested that it may be due to the downward leaching of PAH contaminated particles or to the placement of uncontaminated soil over a contaminated layer with ongoing deposition contaminating the new material (MOE, 2010).

The Ministry's 2012 surface soil (0-5 cm) survey included properties in the Bayview neighbourhood as well as three residential properties in the area north of Wallace Terrace. Consistent with previous TAU soil surveys in the Bayview neighbourhood, PAH concentrations were often elevated relative to the Ministry's background-based and effects-based standards. In comparing the data from the MOE 2005, 2009 and 2012 surveys (MOE, 2006, 2010, 2013), there was no clear pattern of either increasing or decreasing PAH concentrations with time. In general, elevated PAH contamination tended to be found south of Wallace Terrace, with soil PAH concentrations at the few sampling sites north of Wallace Terrace at background levels. The steel works was identified as the likely source of elevated PAH concentrations in the Bayview neighbourhood soils. It was not clear, however, whether some of the PAH contamination reported might be related to buried fill material on some properties, or how much of the PAH contamination could be attributed to other sources.

In 2013, the Ministry's Sudbury District Office requested that the TAU expand the number of sampling sites in the neighbourhood north of Wallace Terrace (bounded by Wallace Terrace, Second Line West, Rowell Avenue and Third Avenue) to obtain a better measure of PAH concentrations in soils in this neighbourhood. The District Office also requested the digging of soil pits on select residential properties in the Bayview neighbourhood in order to try to establish a connection between elevated PAH concentrations and particles/materials identified in these soil.



Map 1: MOECC residential soil sampling sites north of Wallace Terrace (yellow dots) and MOECC soil pit sampling sites in the Bayview neighbourhood (orange dots), Sault Ste. Marie, Ontario – 2013.

2.0 Methods

2.1 Residential Soil Sampling North of Wallace Terrace

On September 17 and 19, 2013, TAU staff sampled soil from either the front or side yards of 15 residential properties in the neighbourhood north of Wallace Terrace (Maps 1and 2). At each sampling site, an area of the lawn was delineated with orange plastic traffic cones, a picture of the plot was taken with a digital camera (Canon Rebel XT) and a sketch map was drawn of the area sampled. Soil cores were collected by inserting a stainless steel soil corer (2.5 cm internal diameter) into the soil to a depth of 30 cm or refusal. The soil corer was extracted and the resulting core of soil was divided into four depth intervals; 0-5, 5-10, 10-20 and 20-30 cm. The plugs of soil from each sampling depth were collected in four new polyethylene bags that corresponded to the sampling depths. This process was repeated at nine locations in a 3 x 3 grid sampling pattern across the delineated area. Each bag of nine plugs of soil for each sampling

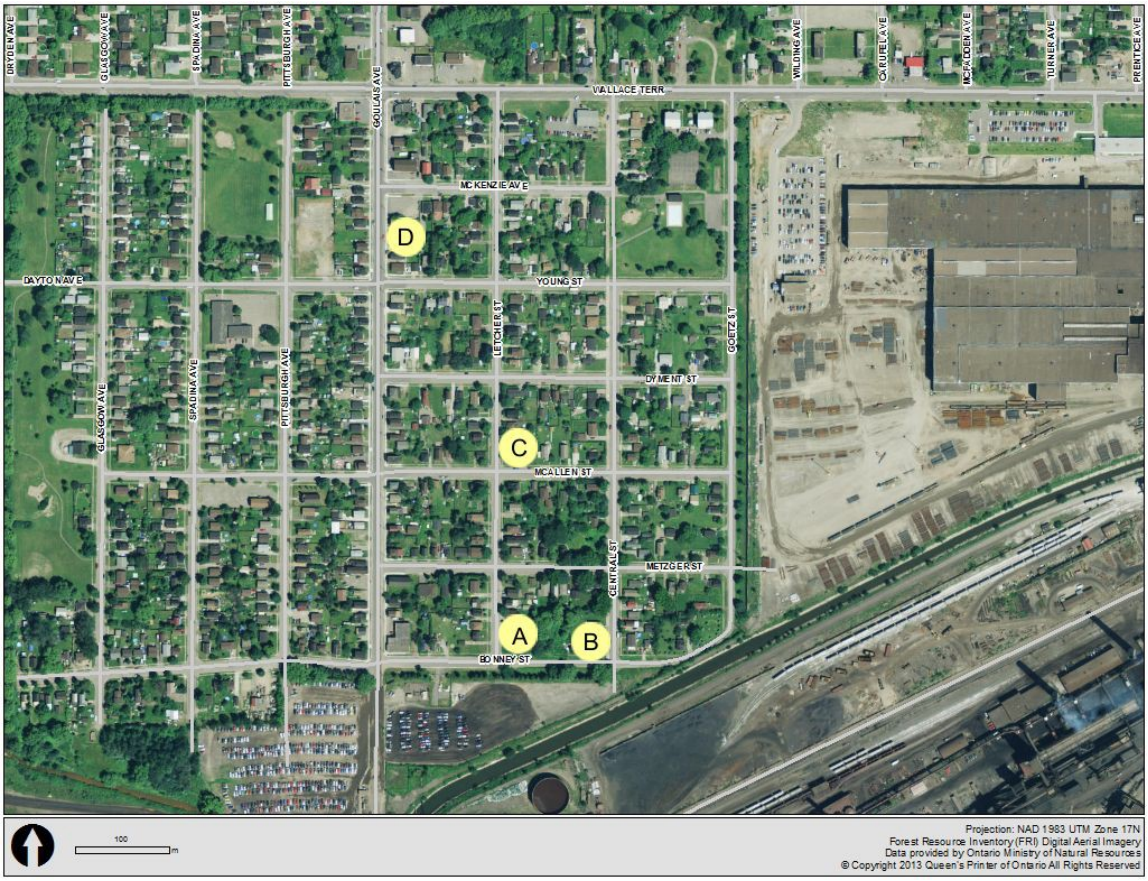
depth was considered to be one composite sample. This process was repeated to collect duplicate samples per site. Each bag of soil was tied shut and each composite soil sample was homogenized by hand in order to mix the soil and break up any lumps. The soil from each bag was then poured into a professionally cleaned 180 millilitre amber glass sample jar. In total, 120 jars (15 residential properties x 4 depths x 2 replicates) of soil were collected in this survey. Prior to sampling at each site, the soil corer was washed with a solution of laboratory detergent, rinsed with distilled/de-ionized water, rinsed with acetone, and finally, rinsed with hexane. New disposable chloroprene gloves were worn at each sampling site when collecting the soil samples.

Map 2: MOECC residential soil sampling sites (yellow dots with site numbers) north of Wallace Terrace, Sault Ste. Marie - 2013

2.2 Bayview Neighbourhood Soil Pit Sampling

On September 18, 2013, soil pits were dug on four residential properties in the Bayview neighbourhood (Maps 1 and 2). Sampling sites ranged from about 250 meters (m) to 800 m from the Essar Steel coke ovens. Each pit was dug to a depth of one meter or refusal and was one meter wide at the surface. One face in each pit was smoothed with a stainless steel trowel and layers/horizons were visually identified down the soil profile. The pit was photographed with a digital camera (Canon Rebel XT) and a sketch map was drawn that identified the depth and thickness of each layer, along with a general description of each layer. Samples of soil were collected from several locations within each layer with a stainless steel trowel. The samples were combined in a new polyethylene sample bag to create one composite soil sample from each layer. Prior to sampling the stainless steel trowel was thoroughly washed in a solution of laboratory detergent, then rinsed with distilled/deionized water, rinsed with acetone and finally rinsed with hexane. New disposable chloroprene gloves were worn at each sampling site when collecting the soil samples.

Following collection, the soil samples from both the residential and soil pit sampling were forwarded to the Ministry's analytical laboratory at 125 Resources Road in Toronto, where they were analyzed for PAHs using the laboratory-accredited method 3425L1. All measurements are given as ng/g dry weight. Soil samples collected from Site 207 and all soil pit samples were also submitted for stereoscopic microscope analysis.



Map 3: MOECC soil pit sampling sites (yellow dots with letters) in the Bayview neighbourhood, Sault Ste. Marie - 2013

3.0 Results and Discussion

PAHs are organic compounds (carbon containing compounds) characterized by two or more fused aromatic rings (Weislo, 1998). Some PAHs, such as benzo (a) pyrene (BaP), are considered human carcinogens (cancer forming compounds) and are of concern to human and animal health. PAHs are components of most fossil fuels and are ubiquitous in the natural environment (Wcislo, 1998). Most anthropogenic PAHs are products of incomplete combustion or pyrolysis of fossil fuels. Coke ovens, which are an integral part of the steel making process, are major sources of PAHs. Coke is produced by heating coal to 1100ºC in an oxygen deficient atmosphere, which concentrates the carbon and drives off impurities, including tars and aromatic hydrocarbon compounds (Valia, 2012). The resulting coke (carbonized coal) is used as fuel in the blast furnaces, as a reducing agent to reduce iron oxide to iron, and as a source of carbon in the steel. Essar Steel is a known source of PAHs and the effect of emissions originating from this steel works on area soils and vegetation has been well documented (MOE 2000, MOE 2003, MOE 2006, MOE 2010, MOE 2013). Nevertheless, it is understood that Essar Steel is not the only source of PAHs in the vicinity of the Bayview neighbourhood and that there are other

commercial, industrial and residential sources of PAHs, including coal tar roofing materials, coal tar pavement sealants, creosote wood preservatives, automobile and truck exhaust, heating systems, wood/coal burning fireplaces, and barbeques.

The ministry's soil, ground water, and sediment standards are for use under *Part XV.I* of the *Environmental Protection Act* and are referred to in *Ontario Regulation 153/04 - Records of Site Condition (O. Reg. 153/04)*. These standards were specifically developed to assist landowners in the clean-up and redevelopment of contaminated sites. The environmental standards in *O. Reg. 153/04* are, however, sometimes used to interpret soil, sediment, and ground water quality outside of the purposes of the regulation. In these situations, sampling results that are elevated with respect to the *O. Reg. 153/04* standards do not necessarily indicate that remediation is required or that adverse effects will or have occurred (see Appendix B for more information on the use of the *O. Reg. 153/04* soil standards to interpret soil sampling results).

The Ministry continuously re-evaluates these standards as new scientific information becomes available and the standards for many PAHs were made more stringent in 2011. It should be recognized that this change in standards will mean the PAH concentrations for some soils in this area that previously did not exceed Ministry standards will now exceed these standards and it may appear that the extent of contamination has become worse even though the PAH concentrations may not have changed.

In this report, soil concentrations of PAHs are compared to the background (Table 1) and generic effects-based soil standards (Table 3) found under *O. Reg. 153/04*. BaP was chosen to represent all the measured PAHs because it is used as a surrogate for total PAHs in the Ontario ambient air quality criteria (MOE, 2012). BaP is a known human and animal carcinogen and it is the most thoroughly studied of the PAHs (Wcislo, 1998). There is also a strong correlation between BaP concentrations and most of the other PAH compounds measured in the Ministry's 2013 soil survey (Table A1, Appendix A).

3.1 Residential Soil Sampling North of Wallace Terrace

In the previous TAU soil survey (MOE, 2013), it was concluded that areas to the north of Wallace Terrace tended to have PAH concentrations below or close to background levels (based on limited soil sampling). In the current survey this was not the case, as seven of the fifteen sites sampled (Sites 202, 206, 207, 208, 209, 210, and 211, Figures 1, Table A) reported concentrations of at least one PAH that were elevated with respect to the MOE Table 1 soil standards and six of these sties (Sites 202, 206, 207, 209, 210, and 211, Figures 1, Table A) had concentrations of several PAHs that were elevated with respect to the MOE Table 3 soil standards. The remaining eight properties sampled however reported PAH concentrations well below the Ministry soil standards.

Sampling sites sampled tended to form a dichotomous grouping, with sites having either low PAH concentrations (Sites 200, 201, 203, 204, 205, 212, 213 and 214) or elevated PAH concentrations (Sites 202, 206, 207, 208, 209, 210, and 211) (Figure 1). Interestingly, the low PAH sites were all, except Site 203, on the west side of Goulais Avenue and the elevated PAH sites were all east of Goulais Avenue. Why this is the case is unknown. The properties on the

east side of Goulais Avenue are slightly closer to the Essar Steel property, but not all elevated PAH sites were closer to the coke ovens in comparison to some of the low PAH sites. The large difference in PAH concentrations between these two groups of sites cannot be accounted for by the distance from the Essar Steel property in general or the coke ovens specifically.

The low PAH sites had BaP concentrations at background levels and a pattern of decreasing BaP concentrations with sampling depth. This pattern is consistent with aerial deposition of a contaminant. No foreign material, such as bricks, slag or cinders was observed in any of the soil samples collected from these properties. The soil cores often had loam to loamy sand in the top 15 to 20 cm and a clay layer at about 20 to 30 cm.

The high PAH sites reported BaP concentrations above the MOECC effects-based soil standards (Table 3). These sites were all west of Goulais Avenue. The sites along Wallace Terrace (Sites 209, 210, and 211) had similar BaP concentrations, with no consistent pattern of BaP concentration with sampling depth (Figure 1). Several sites had foreign material in the soil samples, including Sites 206 and 211 that had fragments of brick at various depths. Site 207 had a black gritty layer at about 20 cm and Site 209 had cinder-like material in the soil (Table B1, Appendix B). Although elevated PAH concentrations in soil samples collected from these sites are not necessarily related to the observed foreign material , the presence of such materials indicates that the surface soil has been disturbed and it is likely that there is fill material at these sites.

Only two of the high PAH sites (Sites 207 and 208) had a pattern of decreasing PAH concentrations with depth that is consistent with aerial deposition. Of these sites, Site 208 showed the most consistent pattern and the Essar Steel complex was clearly visible from this site. It is possible that the reported soil PAH concentrations are linked to the aerial deposition of PAH contaminated particulate that originated from the steel works.

Site 207 reported the highest BaP concentrations detected in this survey and although this site was close to Site 208, the BaP concentrations in the surface soil were almost seven times higher. Unlike Site 208, Site 207 did not reported a gradual decrease in BaP concentrations with sampling depth but rather reported much higher BaP concentrations in the two surface layers (0-5 and 5-10 cm) and much lower BaP concentrations at depth (10-20 and 20-30 cm) (Table A, Figure 1). If the reported BaP/PAH contamination had originated from Essar Steel, one would expect particulate known to be emitted by Essar Steel, such as coke, coal, kish, iron/iron oxide and coal soot (MOE, 2007), to be found in the samples, particularly in the surface layers. This type of material was detected in the 5-10 cm soil layer but not in the 0-5 cm soil layer (Appendix B). The only material identified in the 0-5 cm layer that was likely to contain elevated PAH concentrations was fireplace slag (Table B1, Appendix B). The fireplace slag identified in the surface soil (0-5 cm) may not be the main source of the elevated BaP concentrations, since fireplace slag (likely from the same source) was also detected in the deeper layers (10-20 and 20-30 cm) where BaP/PAH concentrations were much lower. Even though material from the steel works was not identified in the sampled surface (0-5 cm) soil, PAHs emitted from coke ovens are primarily associated with fine particulate (<3 um) and it is likely that the source of much of the PAH contamination could not be detected in the samples through microscopic analysis (Broddin et al., 1977).

When collecting the samples at Site 207, it was clear that there was granular material in the soil cores, not consistent with native soils, at the deeper layers (Photo 1). Since this site had the highest PAH concentrations detected in the survey and there was granular material found in the sample, the soil samples from this site were also submitted for stereoscopic microscope analysis. The detailed analysis of the material in all layers is given in Table B1, Appendix B. The granular material was identified as metallurgical slag. This layer of material was considered fill material and not deposited by aerial deposition. Since the PAH concentrations in the layers containing metallurgical slag were much less than in the layers without metallurgical slag, this slag material is not likely the major source of PAHs at this site.

At two sites (Sites 202 and 206), BaP/PAH concentrations were highest at the deeper sampling depths (10-20 and 20-30 cm). Buried horizons on residential properties are often due to landscaping (e.g., re-sodding or re-contouring a lawn) or construction (e.g., excavation of a basement) activities. Fill material can also be brought in to fill in low or poorly drained areas and the fill material may be contaminated.

Sites 209 and 211 did not show any pattern of increasing or decreasing BaP concentrations with sampling depth (Figure 1). It is possible that historically deposited PAHs have been mixed throughout these surface layers by soil organisms, such as earthworms and ants. Nevertheless, this is not the usual pattern for aerial deposition of contaminants. The cinders and brick fragments detected in soil samples from these sites suggest that there may be a relatively homogeneous layer of contaminated fill on these properties. One site, Site 210, had an apparent spike in BaP concentrations at the 10-20 cm depth (Figure 1), which was due to very high BaP concentrations (2100 ng/g BaP) in one of the two replicate samples. The other replicate had a BaP concentration of 330 ng/g. High variability among replicate samples indicates that the sampled soil is very heterogeneous. In this case the high concentration detected may be due to a chunk, nodule or pocket of contamination collected in as few as one of the nine soil cores that composed the composite sample. This pattern of contamination is not consistent with aerial deposition of a contaminant and may not indicate widespread contamination.

Overall, the pattern of PAH contamination at the low PAH sites is consistent with aerial deposition of a contaminant and it is likely that these sites have been impacted by PAH contaminated particulate deposited from the steel works. At the high PAH sites, evidence of foreign material in the soil samples, evidence of pockets of contamination, and inconsistent patterns of contamination even among properties on the same street and within a few hundred meters of each other (i.e., high PAH concentrations in the soil samples collected at Site 202 but not at Sites 201 or 203) suggests that aerial deposition of PAH contaminated particulate is not the only source of PAH contamination at these sites. It is possible that some of this contamination was brought from the steel works as fill material and it is possible that some of the PAH contamination may originate from domestic sources, although there was little evidence of domestic sources.

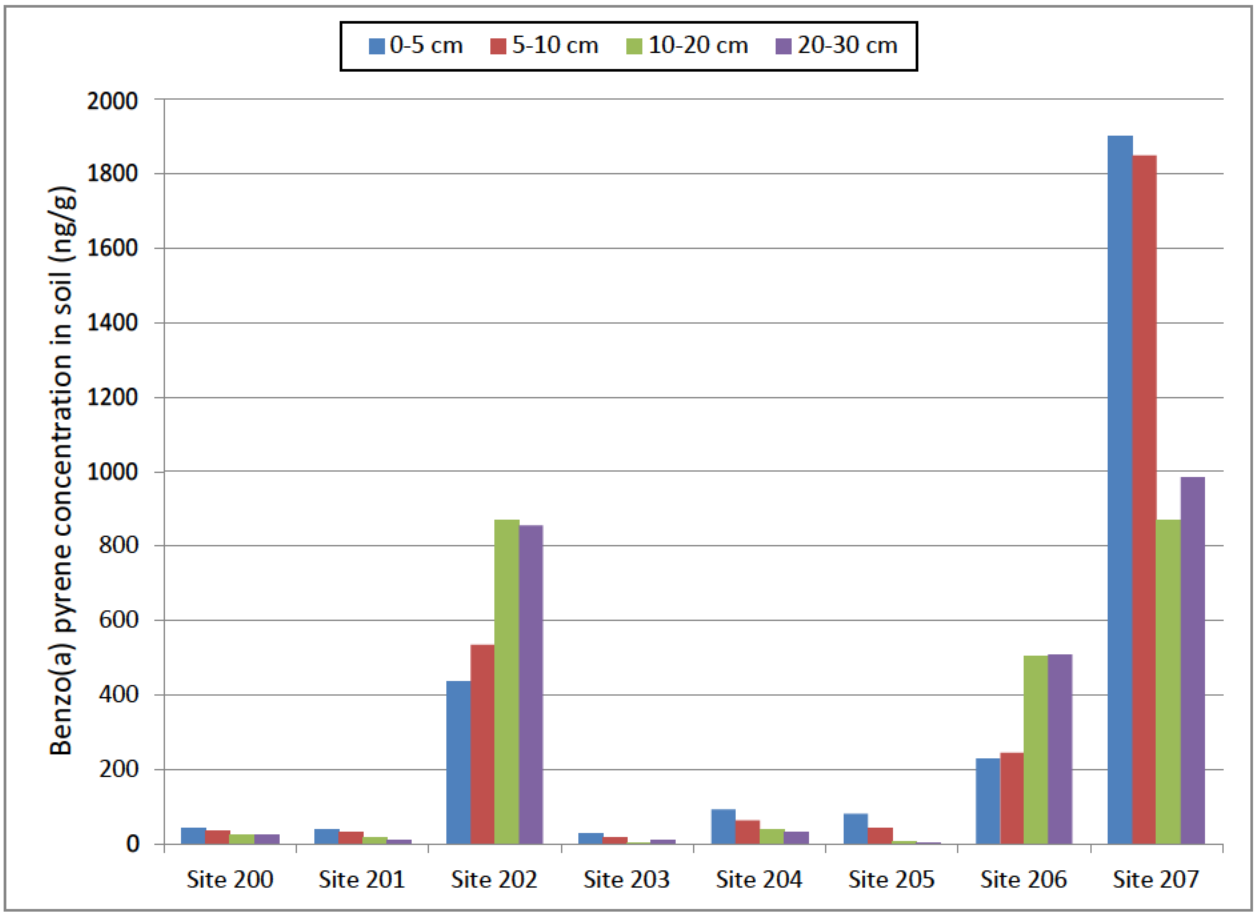


Figure 1: Benzo(a)pyrene concentrations (ng/g) in surface soil samples collected at four depths (0-5, 5-10, 10-20 and 20-30 cm) from the front or side yards of residential properties (Sites 200 to 207) in the vicinity of Essar Steel Algoma, Sault Ste. Marie, Ontario – 2013

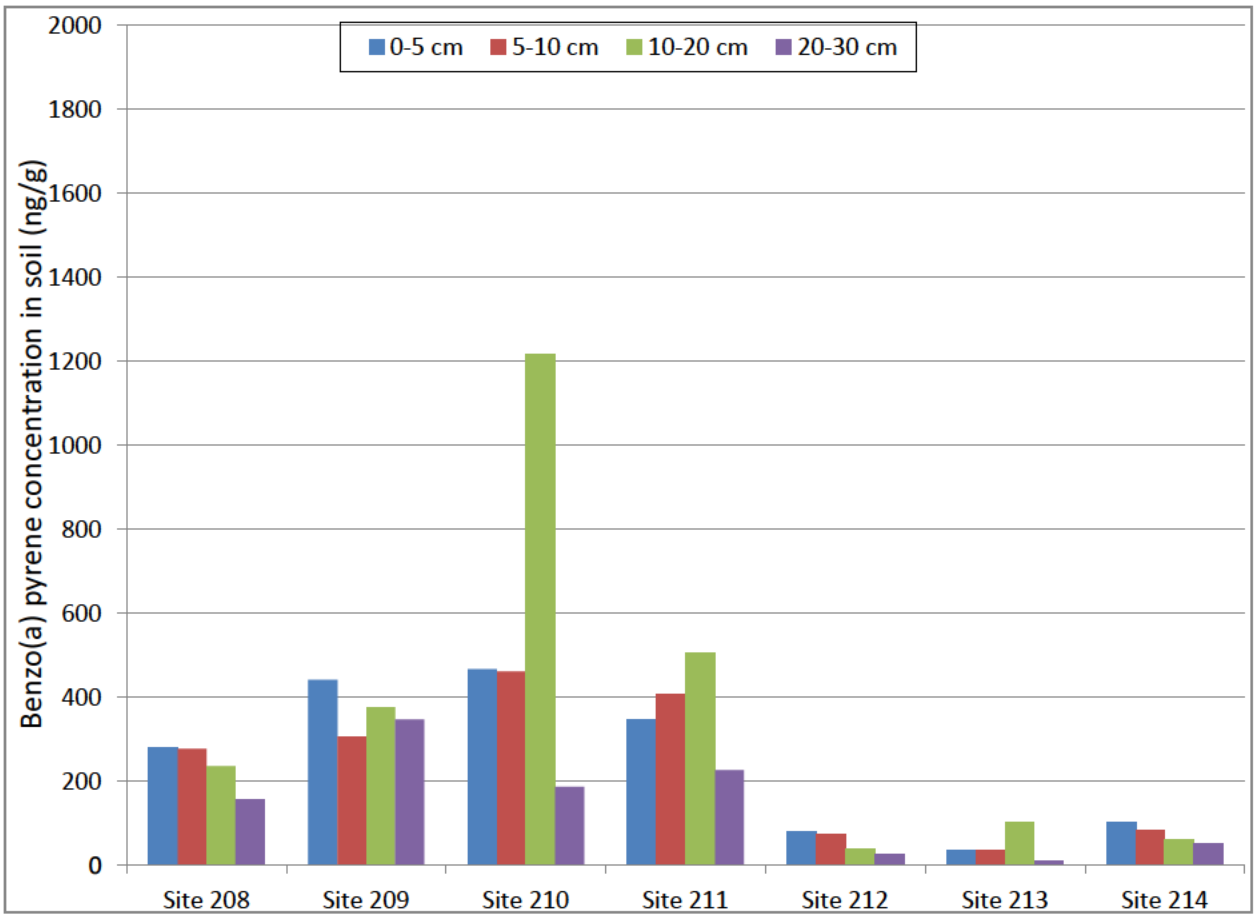


Figure 1 continued: Benzo(a)pyrene concentrations (ng/g) in surface soil samples collected at four depths (0-5, 5-10, 10-20 and 20-30 cm) from the front or side yards of residential properties (Sites 208 to 214) in the vicinity of Essar Steel Algoma, Sault Ste. Marie, Ontario – 2013

Photo 1: Soil core collected at Site 207. The surface layer of loam soil is shown on the right side, with a layer of nodules and black gritty material, sampled at depth, on the left side. (Photo by s.21 , 19 September, 2014)

Table A: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene
200	0-5	771	2.8 <T	7.3 <T	8.8 <T	32	43
200	0-5	772	2.5 <T	7.6 <T	9.3 <T	30	39
200	5-10	773	2.3 <T	6.5 <T	7.6 <T	28	34
200	5-10	774	2 ≤W	6.8 <T	7.9 <T	24	32
200	10-20	775	2.4 <T	6.4 <T	6.6 <T	23	28
200	10-20	776	2 ≤W	5.3 <T	5.4 <T	16 <T	21
200	20-30	777	2 ≤W	4.3 <T	4.6 <T	15 <T	18 <T
200	20-30	778	2.7 <T	6.1 <T	8.6 <T	26	30
201	0-5	779	3.3 <T	6.7 <T	9.8 <T	33	41
201	0-5	780	2.6 <T	7.8 <T	9.6 <T	28	38
201	5-10	781	2.4 <T	5.3 <T	7.5 <T	22	29
201	5-10	782	2.2 <T	5.3 <T	7.7 <T	22	30
201	10-15	783	2 ≤W	2.9 <T	4.1 <T	15 <T	20
201	10-15	784	2 ≤W	3.2 <T	5.7 <T	13 <T	16 <T
201	15-20	785	2 ≤W	2 ≤W	2 ≤W	6.1 <T	7.7 <T
201	15-20	786	2 ≤W	2.4 <T	3 <T	8.4 <T	11 <T
202	0-5	787	8.2 <T	**100**	71	350	**420**
202	0-5	788	27	**120**	110	**380**	**450**
202	5-10	789	12 <T	**140**	96	**460**	**530**
202	5-10	790	10 <T	**160**	120	**450**	**540**
202	10-20	791	20	**240**	**170**	**840**	**1000**
202	10-20	792	9.3 <T	**230**	160	**620**	**740**
202	20-30	793	26	**120**	**330**	**1000**	**1100**
202	20-30	794	9.2 <T	**150**	130	**510**	**610**
203	0-5	795	2.7 <T	6.9 <T	7.2 <T	23	30
203	0-5	796	5.1 <T	5.5 <T	7.7 <T	20	27
203	5-10	797	2 ≤W	3 <T	3.7 <T	14 <T	19 <T
203	5-10	798	2 ≤W	4.2 <T	4.9 <T	13 <T	18 <T
203	10-20	799	2 ≤W	2 ≤W	2 ≤W	4.1 <T	4.8 <T
203	10-20	800	2 ≤W	2.2 <T	2.4 <T	5.9 <T	7.1 <T
203	20-30	801	2 ≤W	2 ≤W	2 ≤W	4.9 <T	5.9 <T
203	20-30	802	2.6 <T	2.6 <T	3.4 <T	8.1 <T	10 <T
Maximum			27	240	330	1000	1100
MOE Table 1			72	93	160	360	300
MOE Table 3			7900	150	670	500	300

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

<T – a measurable trace amount: interpret with caution, ≤W – no measurable response (zero): < reported value

Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene
204	0-5	803	5.2 <T	12 <T	17 <T	76	100
204	0-5	804	4.1 <T	12 <T	16 <T	62	85
204	5-10	805	2.7 <T	9.7 <T	10 <T	49	69
204	5-10	806	2.8 <T	9.8 <T	13 <T	42	57
204	10-20	807	2 ≤W	7.9 <T	6.6 <T	29	37
204	10-20	808	2 ≤W	10 <T	11 <T	31	39
204	20-30	809	2 ≤W	7.5 <T	6.2 <T	25	30
204	20-30	810	2 ≤W	7.6 <T	7.7 <T	24	29
205	0-5	811	3.7 <T	9.4 <T	12 <T	38	52
205	0-5	812	3.9 <T	13 <T	18 <T	73	110
205	5-10	813	2.8 <T	7.1 <T	7.6 <T	38	54
205	5-10	814	2.4 <T	8 <T	8.6 <T	25	31
205	10-20	815	2 ≤W	2.3 <T	3 <T	8.4 <T	9.8 <T
205	10-20	816	2 ≤W	2.9 <T	2.3 <T	3.9 <T	4.5 <T
205	20-30	817	2 ≤W	2 ≤W	3.2 <T	5.5 <T	5.5 <T
205	20-30	818	2 ≤W	2 ≤W	2.2 <T	5.5 <T	5.5 <T
206	0-5	819	7.6 <T	40	30	130	170
206	0-5	820	15 <T	74	71	240	290
206	5-10	821	7.8 <T	52	43	200	250
206	5-10	822	6.7 <T	59	49	190	240
206	10-20	823	7 <T	57	69	230	270
206	10-20	824	11 <T	**280**	**180**	**670**	**740**
206	20-30	825	51	**720**	**620**	**900**	**940**
206	20-30	826	5.5 <T	36	27	67	77
207	0-5	827	36	**150**	**210**	**990**	**1400**
207	0-5	828	**130**	**150**	**490**	**1900**	**2400**
207	5-10	829	52	**230**	**370**	**1300**	**1700**
207	5-10	830	77	**160**	**380**	**1500**	**2000**
207	10-20	831	19 <T	**180**	**170**	**600**	**800**
207	10-20	832	18 <T	**110**	130	**670**	**940**
207	20-30	833	38	**140**	**220**	**690**	**870**
207	20-30	834	66	**100**	**290**	**820**	**1100**
Maximum			130	720	620	1900	2400
MOE Table 1			72	93	160	360	300
MOE Table 3			7900	150	670	500	300

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

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Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene
208	0-5	835	12 <T	85	65	220	280
208	0-5	836	8.8 <T	68	52	210	280
208	5-10	837	9 <T	86	64	220	290
208	5-10	838	8.2 <T	63	55	190	260
208	10-20	839	10 <T	62	52	170	210
208	10-20	840	9 <T	62	51	200	260
208	20-30	841	4.1 <T	42	31	120	150
208	20-30	842	3.9 <T	34	30	130	160
209	0-5	843	15 <T	**140**	120	350	**440**
209	0-5	844	14 <T	**160**	100	350	**440**
209	5-10	845	11 <T	**110**	85	260	**320**
209	5-10	846	7.5 <T	**94**	56	220	290
209	10-20	847	9 <T	**140**	120	280	**350**
209	10-20	848	7.3 <T	**130**	84	340	**400**
209	20-30	849	8 <T	**120**	110	240	290
209	20-30	850	9.1 <T	**130**	95	320	**400**
210	0-5	851	35	**160**	**210**	**500**	**570**
210	0-5	852	18 <T	61	68	270	**360**
210	5-10	853	29	81	140	**400**	**450**
210	5-10	854	24	63	99	**390**	**470**
210	10-20	855	14 <T	71	86	280	**330**
210	10-20	856	26	59	**300**	**1800**	**2100**
210	20-30	857	5 <T	48	45	120	140
210	20-30	858	10 <T	24	55	210	230
Maximum			35	160	300	1800	2100
MOE Table 1			72	93	160	360	300
MOE Table 3			7900	150	670	500	300

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)
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Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.
Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene
211	0-5	859	11 <T	73	74	220	270
211	0-5	860	39	74	120	**370**	**<u>420</u>**
211	5-10	861	8.3 <T	**120**	100	310	**<u>380</u>**
211	5-10	862	8.5 <T	58	70	340	**<u>430</u>**
211	10-20	863	12 <T	**140**	**200**	**380**	**<u>480</u>**
211	10-20	864	15 <T	84	130	**480**	**<u>530</u>**
211	20-30	865	6.2 <T	**110**	90	220	270
211	20-30	866	11 <T	40	35	150	180
212	0-5	867	3.5 <T	12 <T	15 <T	54	71
212	0-5	868	5 <T	11 <T	15 <T	59	87
212	5-10	869	3.4 <T	15 <T	18 <T	54	80
212	5-10	870	3.1 <T	9.6 <T	13 <T	49	66
212	10-20	871	2 ≤W	11 <T	12 <T	28	36
212	10-20	872	2.5 <T	6.7 <T	7.8 <T	31	40
212	20-30	873	2 ≤W	4.9 <T	5.1 <T	19 <T	24
212	20-30	874	2 ≤W	6.5 <T	6.8 <T	20	25
213	0-5	875	2.7 <T	5.3 <T	7.8 <T	25	34
213	0-5	876	3.1 <T	6 <T	7.8 <T	26	36
213	5-10	877	2.2 <T	5.8 <T	7 <T	25	34
213	5-10	878	3 <T	5 <T	6.6 <T	24	32
213	10-20	879	3.4 <T	59	50	140	180
213	10-20	880	2.6 <T	3.1 <T	4.4 <T	15 <T	19 <T
213	20-30	881	2 ≤W	2.3 <T	3.2 <T	8.7 <T	11 <T
213	20-30	882	2 ≤W	2.2 <T	2.3 <T	6.9 <T	8.7 <T
214	0-5	883	5 <T	15 <T	19 <T	75	100
214	0-5	884	4.6 <T	16 <T	18 <T	78	100
214	5-10	885	4.9 <T	15 <T	17 <T	64	84
214	5-10	886	4.7 <T	13 <T	15 <T	64	80
214	10-20	887	3.2 <T	13 <T	14 <T	47	58
214	10-20	888	3.1 <T	10 <T	11 <T	46	59
214	20-30	889	2.3 <T	11 <T	12 <T	38	47
214	20-30	890	3.1 <T	9.1 <T	10 <T	44	52
Maximum			39	140	200	480	530
MOE Table 1			72	93	160	360	300
MOE Table 3			7900	150	670	500	300

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

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Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Benzo(b)fluoranthene		Benzo(g,h,i)perylene		Benzo(k)fluoranthene		Chrysene		Dibenzo(a,h)anthracene	
200	0-5	771	48		40		22		35		9	<T
200	0-5	772	52		37		23		34		9.9	<T
200	5-10	773	39		33		18	<T	34		7.9	<T
200	5-10	774	45		33		19	<T	28		8.8	<T
200	10-20	775	34		30		15	<T	27		7.8	<T
200	10-20	776	28		20		13	<T	19	<T	5.8	<T
200	20-30	777	20		16		9.5	<T	16	<T	4.2	<T
200	20-30	778	39		26		18	<T	27		7.8	<T
201	0-5	779	51		41		22		42		9.5	<T
201	0-5	780	52		39		22		34		9.6	<T
201	5-10	781	35		30		15	<T	28		7	<T
201	5-10	782	44		32		18	<T	28		8.1	<T
201	10-15	783	24		19	<T	11	<T	21		4.8	<T
201	10-15	784	25		17	<T	10	<T	16	<T	4.8	<T
201	15-20	785	10	<T	8	<T	4.7	<T	8.3	<T	2.2	<T
201	15-20	786	18	<T	11	<T	7.5	<T	11	<T	3.6	<T
202	0-5	787	420		330		210		350		90	
202	0-5	788	**490**		330		250		370		99	
202	5-10	789	**510**		390		260		450		**110**	
202	5-10	790	**580**		400		300		410		**120**	
202	10-20	791	**950**		**840**		**490**		780		**220**	
202	10-20	792	**760**		540		400		560		**170**	
202	20-30	793	**980**		**740**		**530**		880		**220**	
202	20-30	794	**630**		400		340		460		**130**	
203	0-5	795	36		27		15	<T	29		7.3	<T
203	0-5	796	37		26		17	<T	26		7	<T
203	5-10	797	22		18	<T	10	<T	18	<T	4.2	<T
203	5-10	798	24		16	<T	11	<T	17	<T	4.4	<T
203	10-20	799	6.6	<T	4.8	<T	3.3	<T	5.4	<T	2	≤W
203	10-20	800	12	<T	6.3	<T	5.3	<T	7.6	<T	2.2	<T
203	20-30	801	7.9	<T	5.5	<T	3.9	<T	6.5	<T	2	≤W
203	20-30	802	13	<T	6.9	<T	6.6	<T	8.9	<T	2.6	<T
Maximum			980		840		530		880		220	
MOE Table 1			470		680		480		2800		100	
MOE Table 3			780		6600		780		7000		100	

MOE Table 1 and Table 3 refer to the Ministry's soil standards for a residential/parkland land use (MOE, 2011)
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Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.
Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene
204	0-5	803	110	90	53	92	21
204	0-5	804	110	77	50	71	20
204	5-10	805	82	66	37	63	15 <T
204	5-10	806	77	52	34	48	14 <T
204	10-20	807	45	35	20	37	8.4 <T
204	10-20	808	52	35	23	34	10 <T
204	20-30	809	34	27	16 <T	30	7 <T
204	20-30	810	38	24	18 <T	25	7.4 <T
205	0-5	811	71	52	30	43	12 <T
205	0-5	812	120	86	56	70	25
205	5-10	813	92	52	39	53	13 <T
205	5-10	814	44	32	19 <T	27	8.4 <T
205	10-20	815	13 <T	10 <T	5.8 <T	11 <T	2.7 <T
205	10-20	816	8.3 <T	4.2 <T	3.8 <T	5.5 <T	2 ≤W
205	20-30	817	7.3 <T	5.1 <T	3.7 <T	6.3 <T	2 ≤W
205	20-30	818	8.5 <T	3.8 <T	4.2 <T	6.2 <T	2 ≤W
206	0-5	819	200	160	91	140	39
206	0-5	820	350	220	160	200	70
206	5-10	821	280	210	130	190	57
206	5-10	822	300	190	140	180	62
206	10-20	823	330	210	160	180	66
206	10-20	824	**970**	590	**500**	600	**200**
206	20-30	825	**940**	630	**500**	780	**220**
206	20-30	826	110	67	50	73	22
207	0-5	827	**1500**	**1200**	**780**	1100	**310**
207	0-5	828	**2400**	**1800**	**1300**	2000	**500**
207	5-10	829	**1800**	**1400**	**940**	1400	**400**
207	5-10	830	**2100**	**1600**	**1100**	1600	**420**
207	10-20	831	**910**	660	450	630	**190**
207	10-20	832	**1100**	**760**	**530**	710	**200**
207	20-30	833	**910**	**700**	450	670	**190**
207	20-30	834	**1100**	**860**	**560**	800	**240**
Maximum			2400	1800	1300	2000	500
MOE Table 1			470	680	480	2800	100
MOE Table 3			780	6600	780	7000	100

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

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Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene
208	0-5	835	370	250	170	200	70
208	0-5	836	370	250	160	210	68
208	5-10	837	390	260	180	200	75
208	5-10	838	360	250	160	190	67
208	10-20	839	290	190	130	150	54
208	10-20	840	350	230	160	190	63
208	20-30	841	200	130	93	120	37
208	20-30	842	230	130	100	130	39
209	0-5	843	**530**	350	260	320	**110**
209	0-5	844	**530**	350	250	350	100
209	5-10	845	400	270	190	250	83
209	5-10	846	360	240	170	210	71
209	10-20	847	420	280	200	270	89
209	10-20	848	**480**	300	230	310	95
209	20-30	849	350	240	160	270	78
209	20-30	850	**490**	340	230	300	100
210	0-5	851	**620**	450	290	540	**130**
210	0-5	852	420	300	180	270	81
210	5-10	853	**500**	360	230	420	**110**
210	5-10	854	**490**	350	220	360	97
210	10-20	855	340	250	150	300	76
210	10-20	856	**1400**	**1100**	**710**	1700	**310**
210	20-30	857	170	120	73	130	35
210	20-30	858	220	160	100	190	44
Maximum			1400	1100	710	1700	310
MOE Table 1			470	680	480	2800	100
MOE Table 3			780	6600	780	7000	100

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

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Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene
211	0-5	859	320	220	140	230	68
211	0-5	860	460	300	220	340	89
211	5-10	861	380	280	180	280	91
211	5-10	862	430	310	220	340	87
211	10-20	863	**500**	340	240	350	**<u>110</u>**
211	10-20	864	**520**	370	280	440	100
211	20-30	865	300	200	140	220	66
211	20-30	866	190	130	96	150	37
212	0-5	867	91	62	38	67	17 <T
212	0-5	868	110	81	50	88	18 <T
212	5-10	869	100	75	42	72	19 <T
212	5-10	870	78	58	35	57	13 <T
212	10-20	871	49	33	20	35	9.4 <T
212	10-20	872	49	36	22	38	8.9 <T
212	20-30	873	30	23	14 <T	24	6.7 <T
212	20-30	874	32	25	14 <T	24	6.1 <T
213	0-5	875	43	34	18 <T	35	7.7 <T
213	0-5	876	45	37	19 <T	33	8.1 <T
213	5-10	877	43	32	19 <T	35	7.5 <T
213	5-10	878	40	30	17 <T	29	7.4 <T
213	10-20	879	170	120	89	140	35
213	10-20	880	24	18 <T	10 <T	19 <T	4.5 <T
213	20-30	881	14 <T	10 <T	6.3 <T	11 <T	2.6 <T
213	20-30	882	12 <T	8.3 <T	5.3 <T	8.9 <T	2.3 <T
214	0-5	883	120	90	53	95	21
214	0-5	884	130	89	57	98	23
214	5-10	885	110	80	47	80	19 <T
214	5-10	886	100	71	45	75	18 <T
214	10-20	887	73	50	33	59	13 <T
214	10-20	888	75	50	33	54	13 <T
214	20-30	889	61	41	27	49	11 <T
214	20-30	890	68	42	30	45	12 <T
Maximum			520	370	280	440	110
MOE Table 1			470	680	480	2800	100
MOE Table 3			780	6600	780	7000	100

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

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Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
200	0-5	771	72	3.9 <T	37	21	45	62
200	0-5	772	69	4.4 <T	37	18 <T	45	62
200	5-10	773	61	3.3 <T	31	17 <T	38	53
200	5-10	774	56	3.5 <T	32	15 <T	36	50
200	10-20	775	48	2.7 <T	29	15 <T	29	43
200	10-20	776	36	2.7 <T	20	9.9 <T	23	33
200	20-30	777	37	2 ≤W	15 <T	8.1 <T	20	32
200	20-30	778	63	4.7 <T	26	9.7 <T	43	56
201	0-5	779	81	5.6 <T	39	30	54	66
201	0-5	780	71	5.2 <T	38	19 <T	47	62
201	5-10	781	52	3.5 <T	28	17 <T	37	44
201	5-10	782	55	4 <T	31	16 <T	38	49
201	10-15	783	33	2.2 <T	18 <T	11 <T	21	30
201	10-15	784	30	3.1 <T	16 <T	9.3 <T	24	27
201	15-20	785	13 <T	2 ≤W	7.4 <T	5.3 <T	9.3 <T	12 <T
201	15-20	786	19 <T	2 ≤W	11 <T	8.1 <T	13 <T	17 <T
202	0-5	787	**660**	15 <T	**330**	52	210	590
202	0-5	788	**800**	41	**340**	66	400	710
202	5-10	789	**830**	20	**390**	59	240	740
202	5-10	790	**860**	18 <T	**410**	51	240	780
202	10-20	791	**1500**	31	**760**	68	380	**1300**
202	10-20	792	**1200**	19 <T	**540**	58	290	**1100**
202	20-30	793	**2100**	53	**710**	57	**820**	**1700**
202	20-30	794	**1000**	19 <T	**430**	47	270	890
203	0-5	795	54	4 <T	29	19 <T	40	47
203	0-5	796	52	5.1 <T	27	25	40	48
203	5-10	797	34	2.2 <T	16 <T	12 <T	24	29
203	5-10	798	30	3 <T	18 <T	18 <T	24	29
203	10-20	799	8.7 <T	2 ≤W	4.7 <T	3.8 <T	6.6 <T	7.9 <T
203	10-20	800	13 <T	2 ≤W	7.9 <T	9 <T	11 <T	12 <T
203	20-30	801	11 <T	2 ≤W	5.2 <T	3.7 <T	7.4 <T	9.1 <T
203	20-30	802	15 <T	2.8 <T	8.8 <T	7.7 <T	13 <T	16 <T
Maximum			2100	53	760	68	820	1700
MOE Table 1			560	120	230	90	690	1000
MOE Table 3			690	62000	380	600	6200	78000

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

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Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
204	0-5	803	200	7.9 <T	83	19 <T	93	160
204	0-5	804	160	6.7 <T	84	18 <T	80	140
204	5-10	805	120	3.9 <T	62	18 <T	54	100
204	5-10	806	110	4.6 <T	57	20	53	97
204	10-20	807	64	2.6 <T	32	14 <T	32	56
204	10-20	808	69	4 <T	39	20	42	64
204	20-30	809	55	2.5 <T	25	11 <T	30	48
204	20-30	810	54	2.8 <T	28	13 <T	30	50
205	0-5	811	89	5.5 <T	50	24	59	78
205	0-5	812	110	6.2 <T	95	29	66	100
205	5-10	813	68	3.7 <T	50	19 <T	44	57
205	5-10	814	56	4.2 <T	34	20	40	49
205	10-20	815	19	2 ≤W	9.4 <T	5.4 <T	14 <T	16 <T
205	10-20	816	9.1 <T	2 ≤W	5.8 <T	7.2 <T	8.7 <T	8.6 <T
205	20-30	817	13 <T	2 ≤W	5.1 <T	3.2 <T	13 <T	11 <T
205	20-30	818	12 <T	2 ≤W	5.6 <T	4.6 <T	7.7 <T	11 <T
206	0-5	819	250	12 <T	150	61	130	230
206	0-5	820	480	22	**250**	69	200	430
206	5-10	821	350	11 <T	210	67	140	330
206	5-10	822	360	12 <T	210	60	130	340
206	10-20	823	430	14 <T	230	47	170	380
206	10-20	824	**1000**	21	**650**	73	210	910
206	20-30	825	**2400**	**600**	**670**	**200**	**2600**	**1700**
206	20-30	826	130	8.2	75	34	68	120
207	0-5	827	**2600**	55	**1100**	69	**1100**	**2000**
207	0-5	828	**5100**	**190**	**1700**	69	**2800**	**3600**
207	5-10	829	**3300**	90	**1300**	83	**1600**	**2500**
207	5-10	830	**4400**	**130**	**1500**	87	**2200**	**3200**
207	10-20	831	**1500**	33	**680**	70	590	**1200**
207	10-20	832	**1700**	31	**750**	71	620	**1400**
207	20-30	833	**1600**	58	**680**	**110**	**910**	**1300**
207	20-30	834	**1900**	80	**820**	**190**	**1300**	**1600**
Maximum			5100	600	1700	200	2800	3600
MOE Table 1			560	120	230	90	690	1000
MOE Table 3			690	62000	380	600	6200	78000

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

<T – a measurable trace amount: interpret with caution, ≤W – no measurable response (zero): < reported value

Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
208	0-5	835	480	19 <T	**270**	74	220	430
208	0-5	836	480	15 <T	**260**	83	200	420
208	5-10	837	490	15 <T	**280**	68	200	430
208	5-10	838	420	14 <T	**260**	86	210	380
208	10-20	839	360	13 <T	210	47	160	320
208	10-20	840	460	14 <T	**250**	65	200	410
208	20-30	841	250	7.5 <T	140	25	91	230
208	20-30	842	290	8.1 <T	150	41	110	250
209	0-5	843	**810**	33	**380**	56	410	710
209	0-5	844	**830**	44	**380**	54	410	700
209	5-10	845	**610**	19 <T	**300**	51	280	530
209	5-10	846	480	14 <T	**260**	44	180	430
209	10-20	847	**620**	18 <T	**290**	27	220	530
209	10-20	848	**760**	21	**340**	41	300	650
209	20-30	849	540	16 <T	**260**	27	190	470
209	20-30	850	**710**	23	**370**	39	280	620
210	0-5	851	**1300**	63	**430**	**100**	**790**	**1100**
210	0-5	852	**600**	27	**310**	**100**	330	590
210	5-10	853	**890**	40	**350**	93	500	810
210	5-10	854	**800**	36	**340**	96	410	840
210	10-20	855	**580**	21	**250**	40	250	620
210	10-20	856	**2900**	32	**930**	48	**1000**	**3700**
210	20-30	857	260	9.7 <T	130	20	120	260
210	20-30	858	420	17 <T	160	27	200	510
Maximum			2900	63	930	100	1000	3700
MOE Table 1			560	120	230	90	690	1000
MOE Table 3			690	62000	380	600	6200	78000

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

<T – a measurable trace amount: interpret with caution, ≤W – no measurable response (zero): < reported value

Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table A continued: PAH concentrations (ng/g) in soil samples collected from residential properties north of Wallace Terrace, Sault Ste. Marie, September 2013

Site	Depth	Field ID	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
211	0-5	859	500	17 <T	230	44	200	440
211	0-5	860	**870**	69	**320**	61	520	740
211	5-10	861	**620**	16 <T	**300**	42	190	570
211	5-10	862	**740**	16 <T	**310**	54	300	620
211	10-20	863	**750**	26	**360**	54	580	690
211	10-20	864	**1100**	31	**370**	41	390	920
211	20-30	865	460	14 <T	220	30	150	430
211	20-30	866	320	11 <T	130	45	130	280
212	0-5	867	130	6.6 <T	65	24	67	110
212	0-5	868	190	8 <T	74	41	130	160
212	5-10	869	140	8.2 <T	75	33	83	120
212	5-10	870	110	4.7 <T	53	29	59	91
212	10-20	871	67	4.1 <T	35	16 <T	41	61
212	10-20	872	71	3.4 <T	33	20	41	62
212	20-30	873	40	2.2 <T	21	12 <T	25	35
212	20-30	874	45	2.7 <T	23	14 <T	27	39
213	0-5	875	57	4.5 <T	29	24	45	46
213	0-5	876	61	4.5 <T	32	27	46	51
213	5-10	877	57	3.6 <T	29	19 <T	41	49
213	5-10	878	55	3.8 <T	27	23	41	46
213	10-20	879	240	7.7 <T	130	24	79	220
213	10-20	880	36	2.7 <T	16	14 <T	26	31
213	20-30	881	21	2 ≤W	9.1 <T	7.6 <T	16 <T	19 <T
213	20-30	882	17 <T	2 ≤W	7.6 <T	8.2 <T	14 <T	14 <T
214	0-5	883	160	7.5 <T	81	41	97	140
214	0-5	884	180	8.2 <T	82	43	110	150
214	5-10	885	150	6.7 <T	74	32	91	120
214	5-10	886	140	6.5 <T	67	42	84	120
214	10-20	887	100	4.5 <T	47	24	58	87
214	10-20	888	100	4.3 <T	47	30	57	87
214	20-30	889	80	3.6 <T	38	20	47	71
214	20-30	890	94	3.8 <T	41	28	51	81
Maximum			1100	69	370	61	580	920
MOE Table 1			560	120	230	90	690	1000
MOE Table 3			690	62000	380	600	6200	78000

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

<T – a measurable trace amount: interpret with caution, ≤W – no measurable response (zero): < reported value

Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards.

Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

3.2 Bayview Neighbourhood Soil Pit Sampling

Soil pits were dug on four residential properties in the Bayview neighbourhood in order to determine if there is any evidence of layers of fill material or buried horizons that may be associated with PAH contamination and to identify material that might be the source of elevated PAH concentrations in these soils. Detailed results of stereoscopic microscope examination of the soil samples are given in Table C1, Appendix C.

In all pits, BaP concentrations were elevated with respect to both the MOE Table 1 and MOE Table 3 soil standards (Table B). The concentrations reported, however, were consistent with soil PAH levels reported in previous MOE soil surveys (MOE, 2012).

Pits A and B were dug on properties across the road from Essar Steel and relatively close to the coke ovens (Map 3). In both these pits, the surface soil contained particles typically emitted from steel works, such as coke, coal, coal soot, graphite, iron fines and slag. This suggests the contamination is likely linked to historic and to a lesser extent current emissions for Essar Steel. Contamination extended to a depth of 60 cm in Pit A and about 70 cm in Pit B. In both pits, there was a buried dark organic layer where PAH contamination was the greatest (Table B). The origin of this buried contaminated layer is unknown, but it may be surface soil that was contaminated in the early years of the steel works and subsequently buried by construction or landscaping activities. The large difference in the extent of contamination between these two pits, which are within about 80 m of each other, suggests that the PAH contamination is not simply from aerial deposition. Microscopic analysis of these samples revealed 40% coal in samples from Pit B (30–40 cm layer), with only traces of coal in the most contaminated layer in Pit A (Table C1, Photo 2 and 3). Although it is unknown whether coal is the main PAH source, it is likely to have contributed to the PAH contamination at Site B.

Pits C and D were about 200 and 500 m farther from the coke ovens than Pit A, respectively (Map 3). Neither of these sites had a buried organic layer with elevated PAH concentrations, as seen in Pits A and B, and the highest PAH concentrations were reported at the surface and decreased with increasing depth (Table B). In Pit C, uncontaminated native soil was encountered at depths greater than 78 cm, but in Pit D there was evidence of contamination (coal soot, fireplace slag, coke and wood char) down to the bottom of the pit at 90 cm. Also, in Pit D there were bricks and large chunks of slag-like material (Photo 6). Based on the microscopic analysis, the PAH contamination may be linked to the presence of coal/coal soot (Table C1, Appendix C). As mentioned previously, PAHs emitted from coke ovens are primarily associated with very fine particulate (<3 um) and since the microscopic analysis can only detect materials down to 20 um, it is possible that the particulate contributing most to the PAH contamination was not detectable using this technique. Other contaminants detected in the samples, such as coke, iron fines, and graphite, are indicative of contamination originating at the steel works but these materials are not considered the sources of PAHs. The fireplace slag detected in Pit D may be a source of PAHs, but since this material was also detected in deeper layers with much lower PAH concentrations, it is unlikely to be the main source of the PAHs in this soil.

Overall, in the soil pits dug in the Bayview neighbourhood, there was evidence of particulate associated with Essar Steel incorporated in soil layers to a depth of at least 70 cm. These were not undisturbed native soils, but rather highly disturbed and mixed soils, with various layers of material, including buried fill. Elevated PAH concentrations in buried layers suggest that the contamination is largely historic. The presence of material in the soil samples that are commonly associated with steel works (such as coke, iron fines, coal soot, and metallurgical slag), suggests the PAH contamination is likely associated with the steel works. The variability in PAH concentrations among layers and between relatively close sites is inconsistent with aerial deposition, which indicates the contamination is likely to be a combination of aerial deposition and contaminated fill. Although the source of the PAH contamination was not clearly identified, microscopic examination of the soil samples suggested that coal and coal soot may be important sources.

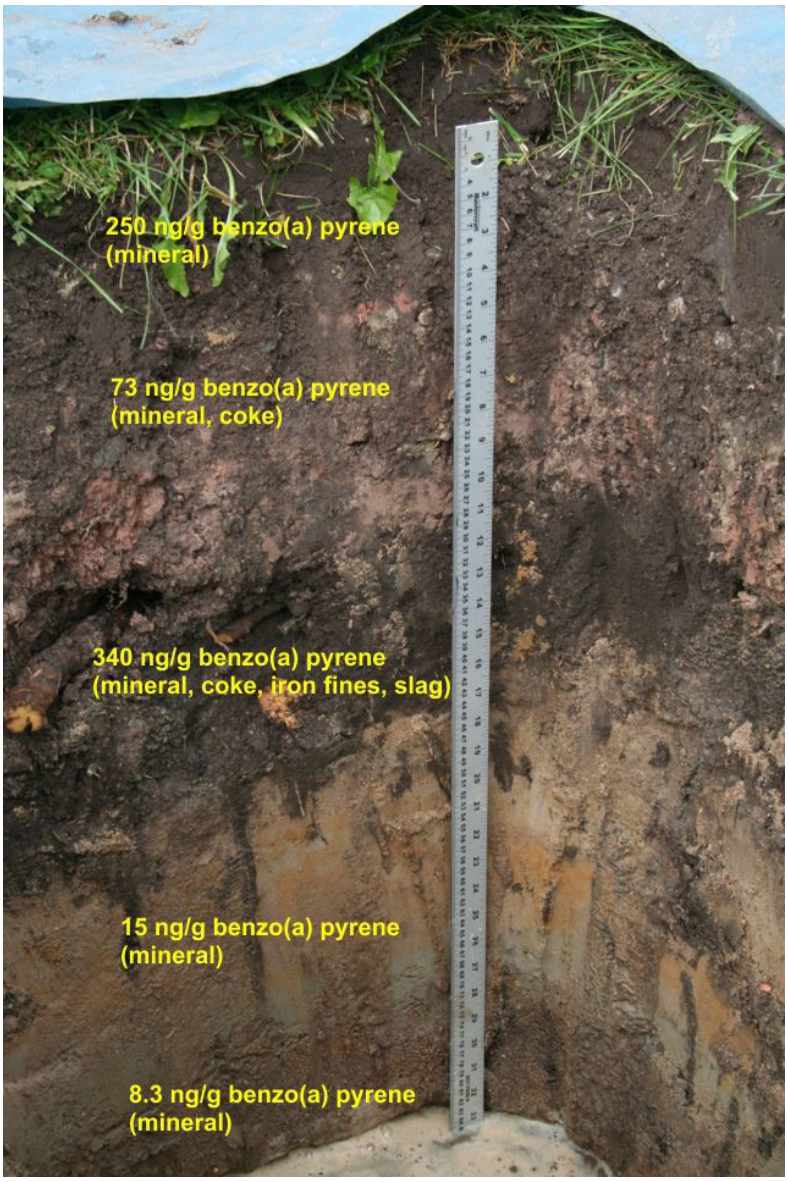

Photo 2: Soil Pit A. Benzo(a)pyrene concentrations and components that comprised more than 10% of the material in each layer/horizon are superimposed on the photograph to correspond to the layer/horizon sampled. (Photo by M. Dixon, 18 September 2013)

Photo 3: Soil Pit B. Benzo(a)pyrene concentrations and components that comprised more than 10% of the material in each layer/horizon are superimposed on the photograph to correspond to the layer/horizon sampled. (Photo by M. Dixon, 18 September 2013)

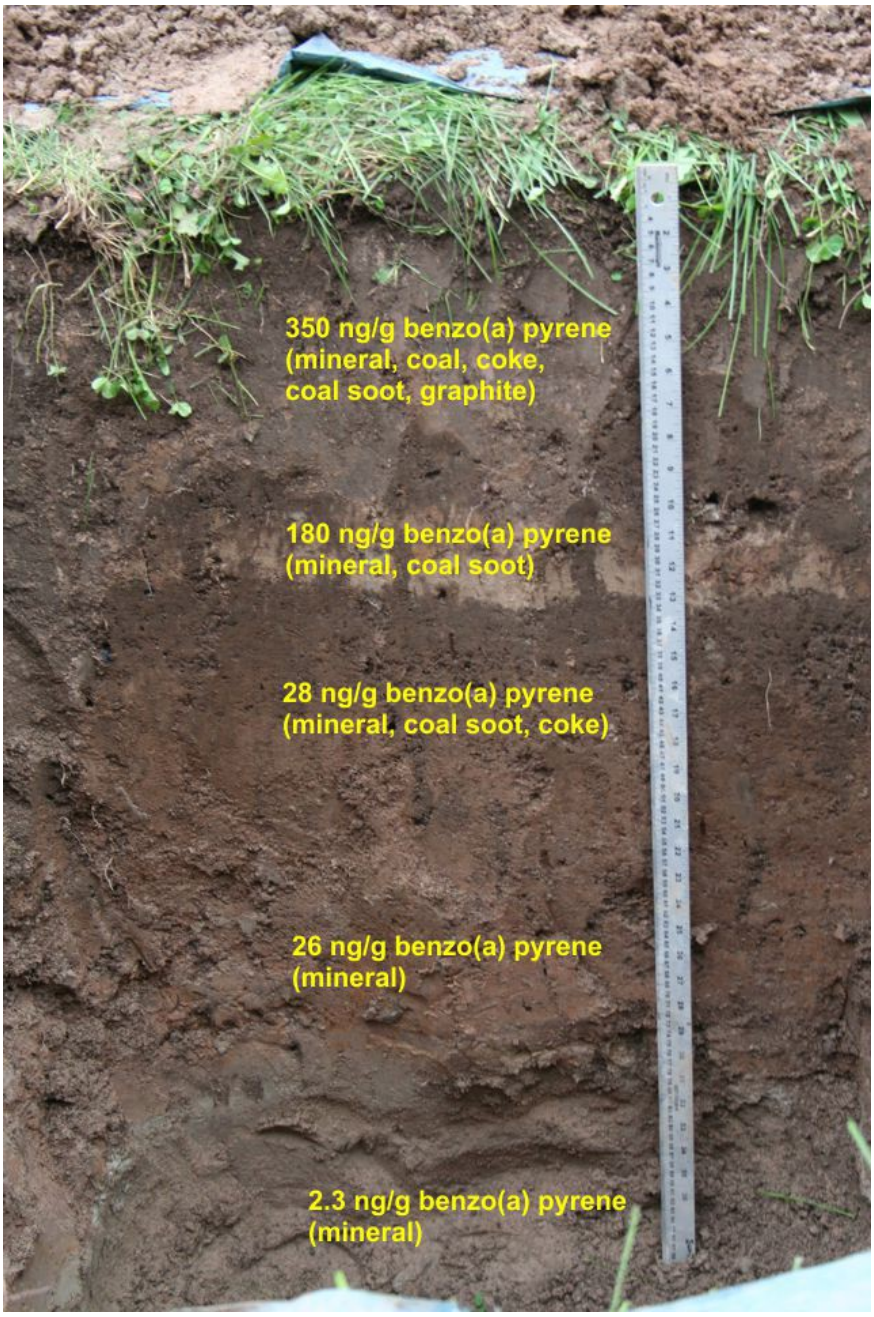

Photo 4: Soil Pit C. Benzo(a)pyrene concentrations and components that comprised more than 10% of the material in each layer/horizon are superimposed on the photograph to correspond to the layer/horizon sampled. (Photo by M. Dixon, 18 September 2013)

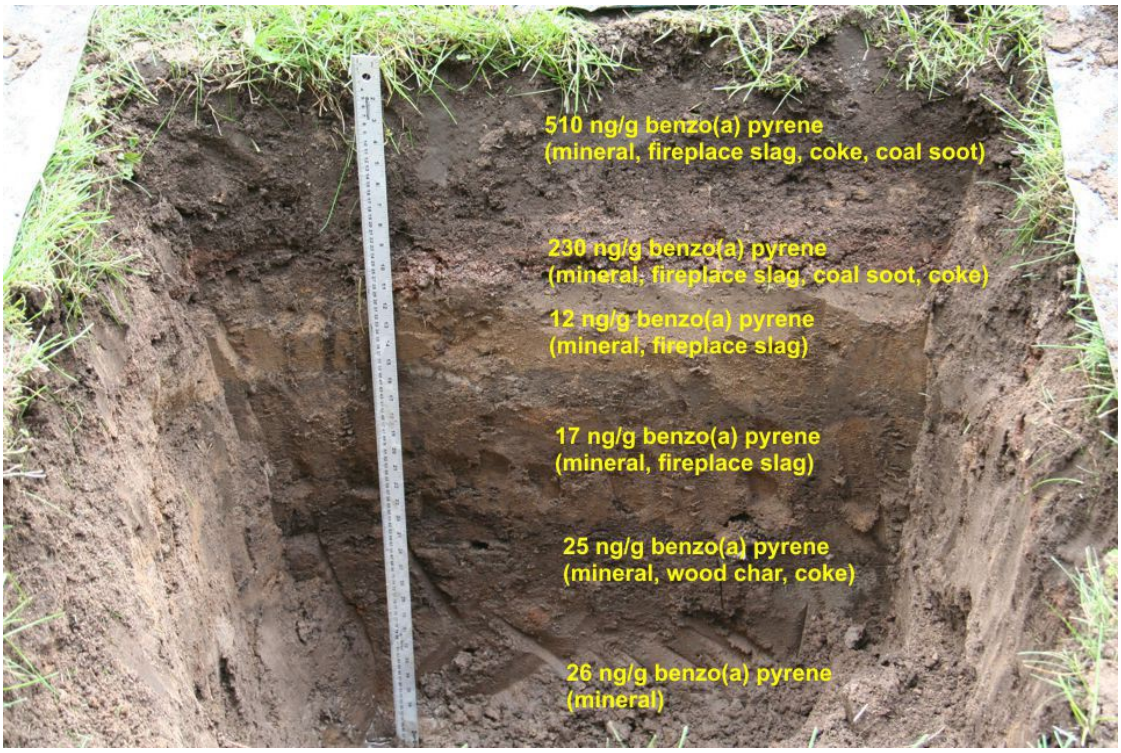

Photo 5: Soil Pit D. Benzo(a)pyrene concentrations and components that comprised more than 10% of the material in each layer/horizon are superimposed on the photograph to correspond to the layer/horizon sampled. (Photo by M. Dixon, 18 September 2013)

Photo 6: Slag-like material taken from the wall of Pit D at a 20 to 26 cm depth. (Photo by M. Dixon, 18 September 2013)

Table B: PAH concentrations (ng/g) in soil collected from soil pits excavated on residential properties in the Bayview neighbourhood near Essar Steel Algoma, Sault Ste. Marie, September 2013

Field number	Pit	Depth	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene
1807	A	0-13	11	53	57	180	250
1808	A	13-35	4.5	19	19	54	73
1809	A	35-46	17	85	81	250	**340**
1810	A	46-60	2	5.1	4.4	11	15
1811	A	60-74	2	2.3	2.2	6.1	8.3
1812	A	74-100	2	2.8	2.3	4.8	6.2
1813	B	0-15	14	**140**	130	**380**	**460**
1814	B	15-30	24	**120**	**200**	**500**	**590**
1815	B	30-40	54	**470**	**400**	**1000**	**1400**
1816	B	40-72	7.7	**130**	130	**380**	**440**
1817	B	72-92	2	4	2.6	4.2	5.5
1818	B	92-100	2	3.5	2.7	5.9	7.3
1819	C	0-25	11	91	89	260	**350**
1820	C	25-33	4.6	65	45	130	180
1821	C	33-64	2.1	9.7	6.9	21	28
1822	C	64-78	2	7.7	6.2	17	26
1823	C	78-100	2	2	2	2	2.3
1824	D	0-20	15	**150**	110	340	**510**
1825	D	20-26	7.1	57	54	180	230
1826	D	26-39	2	5.2	3.8	8.5	12
1827	D	39-59	2	7.5	5.8	13	17
1828	D	59-76	2	9.2	7.2	19	25
1829	D	76-90	2	10	7.7	18	26
Maximum			54	470	400	1000	1400
O. Reg. 153/04 Table 1			72	93	160	360	300
O. Reg. 153/04 Table 3			7900	150	670	500	300

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

<T – a measurable trace amount: interpret with caution

Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards. Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table B continued: PAH concentrations (ng/g) in soil collected from soil pits excavated on residential properties in the Bayview neighbourhood near Essar Steel Algoma, Sault Ste. Marie, September 2013

Field number	Site	Depth	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene
1807	A	0-13	330	220	140	210	56
1808	A	13-35	110	66	45	62	18
1809	A	35-46	440	280	200	270	81
1810	A	46-60	21	13	9.4	14	4.1
1811	A	60-74	11	6.9	5.5	6.4	2.6
1812	A	74-100	8.7	5.5	4.4	5.5	2.2
1813	B	0-15	**500**	360	250	350	**110**
1814	B	15-30	**600**	410	310	490	**110**
1815	B	30-40	**1500**	**1100**	**730**	1100	**290**
1816	B	40-72	**480**	320	240	330	99
1817	B	72-92	6.7	4.5	3.7	4.4	2.1
1818	B	92-100	8.7	5.7	4.7	5.5	2.3
1819	C	0-25	470	310	220	370	84
1820	C	25-33	250	150	110	140	43
1821	C	33-64	41	23	18	26	7.4
1822	C	64-78	43	21	19	25	6.3
1823	C	78-100	3.2	2	2.1	2.5	2
1824	D	0-20	**590**	430	280	380	**110**
1825	D	20-26	310	200	140	190	52
1826	D	26-39	15	10	7.4	9.3	3.5
1827	D	39-59	22	16	10	14	4.7
1828	D	59-76	37	26	16	22	7.2
1829	D	76-90	33	23	16	20	6.5
Maximum			1500	1100	730	1100	290
O. Reg. 153/04 Table 1			470	680	480	2800	100
O. Reg. 153/04 Table 3			780	6600	780	7000	100

MOE Table 1 and Table 3 refer to the Ministry's soil standards for a residential/parkland land use (MOE, 2011)
<T – a measurable trace amount: interpret with caution
Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards. Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

Table B continued: PAH concentrations (ng/g) in soil collected from soil pits excavated on residential properties in the Bayview neighbourhood near Essar Steel Algoma, Sault Ste. Marie, September 2013

Field number	Site	Depth	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
1807	A	0-13	400	21	210	**150**	250	350
1808	A	13-35	120	7.2	66	55	89	110
1809	A	35-46	**600**	32	**280**	**190**	370	510
1810	A	46-60	28	2.6	14	13	21	24
1811	A	60-74	11	2	7.6	4.8	6.8	10
1812	A	74-100	10	2	6.2	4.1	8.1	9.8
1813	B	0-15	**790**	30	**360**	**150**	380	720
1814	B	15-30	**1300**	50	**400**	**220**	**800**	**1100**
1815	B	30-40	**2900**	**140**	**1100**	**530**	**2000**	**2500**
1816	B	40-72	**880**	24	**330**	**100**	390	760
1817	B	72-92	7.2	2	5.1	2.3	5	7.8
1818	B	92-100	11	2	6.5	4	7.2	11
1819	C	0-25	530	20	**300**	78	230	480
1820	C	25-33	290	11	160	33	110	270
1821	C	33-64	43	3.4	25	14	23	39
1822	C	64-78	45	3.1	23	13	22	40
1823	C	78-100	3.3	2	2.7	2.5	4.1	3.3
1824	D	0-20	**940**	30	**400**	**100**	470	800
1825	D	20-26	410	14	200	53	220	360
1826	D	26-39	19	2	11	4.9	11	19
1827	D	39-59	34	2.7	16	8	22	32
1828	D	59-76	44	3.2	26	16	29	40
1829	D	76-90	50	3.9	24	7.8	29	44
Maximum			2900	140	1100	530	2000	2500
O. Reg. 153/04 Table 1			560	120	230	90	690	1000
O. Reg. 153/04 Table 3			690	62000	380	600	6200	78000

MOE Table 1 and Table 3 refer to the Ministry's *Ontario Regulation 153/04 - Records of Site Condition* soil standards for a residential/parkland land use (MOE, 2011)

<T – a measurable trace amount: interpret with caution

Values in bold are elevated with respect to *O. Reg. 153/04* Table 1 background soil standards. Values in bold and underlined are elevated with respect to *O. Reg. 153/04* Table 3 generic effects based soil standards

4.0 Conclusions

Soil samples were collected from the front or side yards of fifteen residential properties located north of Wallace Terrace in Sault Ste. Marie, Ontario. Eight of the fifteen properties sampled reported PAH concentrations well below the Ministry soil standards. These properties tended to report the highest PAH concentrations at the soil surface, with decreasing PAH concentrations with increasing soil depth. The PAH contamination is likely to be from historic aerial deposition of PAH contaminated particulate originating from Essar Steel.

Seven of the fifteen properties sampled had concentrations of at least one PAH that were elevated with respect to the MOE Table 1 soil standards and six of these sites had concentrations of several PAHs that were elevated with respect to the MOE Table 3 soil standards. The seven sites that were elevated with respect to the Ministry's soil standards were all located east of Goulais Avenue and within one kilometer of Essar Steel, but there was no clear pattern of PAH contamination with distance from the steel works. There was evidence of buried material and altered soil horizons/layers on many of these properties and although all properties would be affected by the aerial deposition of PAH contaminated particulate from Essar Steel, it is likely that some of the PAHs detected were associated with fill material. Although the steel works is a source of PAHs, other sources, including industrial and domestic, may have contributed to the contamination.

In four soil pits dug in the Bayview neighbourhood, there was evidence of particulate associated with Essar Steel incorporated in soil layers to a depth of at least 70 cm. These soil layers were not undisturbed native soil and there was evidence of buried material and mixed layers of material in all pits. Elevated PAH concentrations in a buried layer detected at two pits dug on residential properties directly across a road from Essar Steel may be from historically contaminated surface soil that had been buried due to construction or possibly landscaping activities. In all soil pits, the presence of materials that are commonly associated with steel works (such as coke, iron fines, coal soot, and metallurgical slag), suggests the PAH contamination is likely associated with Essar Steel. The variability in PAH concentrations among layers and between relatively close sites suggests that these sites have not simply been contaminated by the aerial deposition of PAH contaminated particulate or that the higher concentrations at depth are due to leaching of PAH contaminated particulate. It is likely that the PAH contamination is the result of both aerial deposition and the dumping of PAH contaminated materials on these properties. Although the source of the PAH contamination was not clearly identified, microscopic examination of the soil samples suggested that coal and coal soot may be important sources.

5.0 References

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Appendix A:

Table A1: Pearson product-moment correlation matrix of PAHs in soil samples collected in the Bayview neighbourhood of Sault Ste. Marie, September 2013

	Acenaphthene	*Acenaphthylene*	*Anthracene*	*Benzo(a)anthracene*	*Benzo(a)pyrene*
Acenaphthene	1				
Acenaphthylene	0.245475221	1			
Anthracene	0.773778717	0.759782338	1		
Benzo(a)anthracene	0.800085077	0.737149306	0.981118158	1	
Benzo(a)pyrene	0.757036713	0.786670719	0.957572719	0.984255845	1
Benzo(b)fluoranthene	0.715644004	0.807759967	0.953515571	0.97886545	0.995116973
Benzo(g,h,i)perylene	0.687576155	0.818428063	0.921213908	0.946709039	0.986297174
Benzo(k)fluoranthene	0.743718257	0.790989027	0.954885923	0.982379375	0.998317428
Chrysene	0.799452067	0.721070353	0.967702775	0.992312144	0.983383261
Dibenzo(a,h)anthracene	0.645597731	0.868602449	0.945497648	0.963022925	0.982019717
Fluoranthene	0.875942072	0.601662647	0.9562779	0.970482859	0.946699609
Fluorene	0.885718814	0.472239663	0.89989967	0.896633838	0.838264845
Indeno(1,2,3-c,d)pyrene	0.652514387	0.854780439	0.929518008	0.951650454	0.986012167
Naphthalene	0.387307649	0.594469599	0.678935688	0.684871545	0.640689248
Phenanthrene	0.917703128	0.39527134	0.869185845	0.870753041	0.818921279
Pyrene	0.867704713	0.641988009	0.96836902	0.982522716	0.96506925

	Benzo(b)fluoranthene	*Benzo(g,h,i)perylene*	*Benzo(k)fluoranthene*	*Chrysene*	*Dibenzo(a,h)anthracene*
Acenaphthene					
Acenaphthylene					
Anthracene					
Benzo(a)anthracene					
Benzo(a)pyrene					
Benzo(b)fluoranthene	1				
Benzo(g,h,i)perylene	0.986129473	1			
Benzo(k)fluoranthene	0.997513805	0.985080306	1		
Chrysene	0.983229458	0.951397264	0.983776039	1	
Dibenzo(a,h)anthracene	0.9906512	0.980743237	0.983379975	0.962264008	1
Fluoranthene	0.938680315	0.902218475	0.94676464	0.972230213	0.89636838
Fluorene	0.832753565	0.779039803	0.834985111	0.903200558	0.795927397
Indeno(1,2,3-c,d)pyrene	0.991827876	0.994815865	0.987134819	0.954720846	0.992790776
Naphthalene	0.685961963	0.629608183	0.651758317	0.706252613	0.721971371
Phenanthrene	0.810182892	0.761428277	0.819397327	0.882910894	0.753726249
Pyrene	0.954027026	0.923727488	0.962258021	0.981298237	0.918175162

	Fluoranthene	*Fluorene*	*Indeno (1,2,3-c,d)pyrene*	*Naphthalene*	*Phenanthrene*	*Pyrene*
Acenaphthene						
Acenaphthylene						
Anthracene						
Benzo(a)anthracene						
Benzo(a)pyrene						
Benzo(b)fluoranthene						
Benzo(g,h,i)perylene						
Benzo(k)fluoranthene						
Chrysene						
D benzo(a,h)anthracene						
Fluoranthene	1					
Fluorene	0.94101588	1				
Indeno(1,2,3-c,d)pyrene	0.897202071	0.774616438	1			
Naphthalene	0.616382393	0.719996854	0.66072051	1		
Phenanthrene	0.947859591	0.981306825	0.747296796	0.627911435	1	
Pyrene	0.995563305	0.924327814	0.919054943	0.607846517	0.923560692	1

Appendix B:

Stereoscopic microscope analysis of soil samples collected from various layers from the front yard of residential property Site 207 in the neighbourhood north of Wallace Terrace, Sault Ste. Marie, September 2013

Environmental Forensics Section

SUBMISSION: C210500
FIELD NO. 827 to 834
LAB.NO.SAMPLE: C210500-0001 to 0008
AUTHORED BY: Eva Just-Przygodzka

Eight soil material samples were received from S. S. Marie. The samples were taken in vicinity of Algoma Steel Inc. Industrial pollution was suspected.

The material was examined by means of stereoscopic microscope.

The sample number (e.g., C210500-0001) is followed by a bracket (e.g., 827- Site 207 0 – 5 cm), which gives the field number (827), the Site (Site 207) and the depth interval collected (0- 5 cm).

Microscopical analyses indicated the presence of the following material:

SAMPLE NO. C210500-0001 (827- Site 207 0 – 5 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud, clay material	60%
2. Vegetation fibres and chips	40%
3. Fireplace slag	Traces
4. Red brick debris	Traces
5. Iron nail	1 nail

SAMPLE NO. C210500-0002 (828- Site 207 0 – 5 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	70%
2. Vegetation fibres and chips (same of chips decayed –black chips)	30%
3. Fireplace slag	Traces

SAMPLE NO. C210500-0003 (829- Site 207 5 - 10 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	65%
2. Coke	10%
3. Coal soot	10%
4. Vegetation fibres and chips	10%
5. Magnetic iron fines, plates, spheres	5%

SAMPLE NO. C210500-0004 (830- Site 207 5 - 10 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	70%
2. Coke	10%
3. Coal soot	10%
4. Magnetic iron fines, plates, spheres	5%
5. Vegetation fibres and chips	5%
6. Coal	Traces

SAMPLE NO. C210500-0005 (831- Site 207 10 - 20 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	70%
2. Coke	10%
3. Fireplace slag	10%
4. Magnetic fines, plates, spheres	5%
5. Vegetation chips and fibres	5%
6. Coal	Traces
7. Metallurgical slag	Traces

SAMPLE NO. C210500-0006 (832- Site 207 10 - 20 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	75%
2. Vegetation fibres and chips	10%
3. Coke	5%
4. Magnetic iron fines, plates, spheres	5%
5. Fireplace slag	5%
6. Hard coal	Traces
7. Wood char	Traces

SAMPLE NO. C210500-0007 (833- Site 207 20 - 30 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Ground rocks and minerals	70%
2. Metallurgical slag	10%
3. Coal soot	5%
4. Hard coal	5%
5. Fireplace slag	5%
6. Vegetation fibres and chips	5%

SAMPLE NO. C210500-0008 (834- Site 207 20 - 30 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	65%
2. Metallurgical slag	10%
3. Vegetation chips and fibres	10%
4. Coke	5%
5. Hard coal	5%
6. Fireplace slag	5%

CONCLUSIONS:

The above soil samples contained particulate material which may have originated from the following sources:

Foundry emissions: coke, magnetic iron fines, plates, spheres, coal soot, metallurgical slag

Gangue material: ground rocks and minerals

Coal piles: hard coal, coal

Combustion products from a low efficiency furnace: wood char, coal soot, fireplace slag

Environment: mineral gravel, sand, mud, clay, vegetation fibres and chips

Grinding operation, waste from construction site etc.: ground rocks and minerals

Appendix C:

Stereoscopic microscope analysis of soil samples collected from various layers from four soil pits (Pit A to Pit D) in the Bayview neighbourhood of Sault Ste. Marie, September 2013

Environmental Forensics Section

SUBMISSION: C210180
FIELD NO. 1807 to 1829
LAB.NO.SAMPLE: C210180-0001 to 0023
AUTHORED BY: Eva Just-Przygodzka

Twenty three soil material samples were received from Sault Ste. Marie. The samples were taken in vicinity of Essar Steel (formerly Algoma Steel Inc.). Industrial pollution was suspected.

The material was examined by means of stereoscopic microscope.

The sample number (e.g., C210180-0001) is followed by a bracket (e.g., 1807- Pit A 0 – 13 cm), which gives the field number (1807), the Pit (Pit A) and the depth interval of the layer (0-13 cm).

Microscopical analyses indicated the presence of the following material:

SAMPLE NO. C210180-0001 (1807- Pit A 0 – 13 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	80%
2. Magnetic iron fines, plates	5%
3. Metallurgical slag	5%
4. Wood fibres and chips	5%
5. Vegetation fibres and chips	5%

SAMPLE NO. C210180-0002 (1808- Pit A 13 – 35 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	80%
2. Coke	10%
3. Magnetic iron fines, plates, spheres	5%
4. Coal soot	5%
5. Coal	Traces
6. Wood chips	Traces
7. Wood char	Traces
8. Metallurgical slag	Traces

SAMPLE NO. C210180-0003 (1809- Pit A 35 - 46 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, mud material	60%
2. Coke	20%
3. Magnetic iron fines, plates, spheres	10%
4. Metallurgical slag	10%
5. Coal	Traces

SAMPLE NO. C210180-0004 (1810- Pit A 46 - 60 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	100%

SAMPLE NO. C210180-0005 (1811- Pit A 60 - 74 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	100%
2. Wood char	Traces
3. Coke	Traces
4. Vegetation fibres	Traces

SAMPLE NO. C210180-0006 (1812- Pit A 74 - 100 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	100%
2. Vegetation fibres	Traces

SAMPLE NO. C210180-0007 (1813- Pit B 0 – 15 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	20%
2. Coal soot	20%
3. Coke	20%
4. Coal	10%
5. Graphite	10%
6. Magnetic iron fines, plates, spheres	10%
7. Wood fibres	5%
8. Wood char	5%
9. Fly ash (black, brown hollow spheres)	Traces

10. Fireplace slag	Traces

SAMPLE NO. C210180-0008 (1814- Pit B_15 - 30 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	40%
2. Coke	20%
3. Magnetic iron fines, plates, spheres	10%
4. Coal soot	10%
5. Coal	10%
6. Graphite	5%
7. Wood char	5%
8. Fireplace slag	Traces

SAMPLE NO. C210180-0009 (1815- Pit B_30 - 40 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	50%
2. Coal	40%
3. Coke	5%
4. Vegetation fibres	5%
5. Coal soot	Traces
6. Asphalt particles	Traces

SAMPLE NO. C210180-0010 (1816- Pit B 40 - 72 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	45%
2. Coal soot	20%
3. Coke	10%
4. Wood chip	10%
5. Wood char	10%
6. Coal	5%

SAMPLE NO. C210180-0011 (1817- Pit B 72 - 92 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	100%

SAMPLE NO. C210180-0012 (1818- Pit B >92 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, clay material	100%
2. Vegetation fibres and chips	Traces

SAMPLE NO. C210180-0013 (1819- Pit C 0 – 25 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, clay material	50%
2. Coal	10%
3. Coke	10%

4. Coal soot	10%
5. Graphite	10%
6. Vegetation fibres and chips	5%
7. Wood char	5%

SAMPLE NO. C210180-0014 (1820- Pit C 25 - 33 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, clay material	80%
2. Coal soot	10%
3. Coal	5%
4. Coke	5%
5. Wood char	Traces
6. Magnetic iron fines, plates, spheres	Traces

SAMPLE NO. C210180-0015 (1821- Pit C 33 - 64 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, clay material	80%
2. Coal soot	10%
3. Coke	10%
4. Graphite	Traces

SAMPLE NO. C210180-0016 (1822- Pit C 64 - 78 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral clay, sand, mud material	100%
2. Coke	Traces
3. Vegetation fibres	Traces

SAMPLE NO. C210180-0017 (1823- Pit C 78 - 100 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral sand, mud, clay material	100%
2. Wood char	Traces

SAMPLE NO. C210180-0018 (1824 – Pit D 0 – 20 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	60%
2. Fireplace slag	20%
3. Coke	10%
4. Coal soot	10%
5. Coal	Traces
6. Wood char	Traces
7. Asphalt particles from roof shingles	Traces

SAMPLE NO. C210180-0019 (1825 – Pit D 20 - 26 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	40%
2. Fireplace slag	30%
3. Coal soot	20%
4. Coke	10%
5. Coal	Traces
6. Graphite	Traces

SAMPLE NO. C210180-0020 (1826 – Pit D 26 - 39 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	80%
2. Fireplace slag	10%
3. Coke	5%
4. Wood char	5%
5. Coal soot	Traces

SAMPLE NO. C210180-0021 (1827 – Pit D 39 - 59 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	80%
2. Fireplace slag	10%
3. Coke	5%
4. Coal soot	5%

5. Wood char	Traces

SAMPLE NO. C210180-0022 (1828 – Pit D 59 - 76 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand, clay material	70%
2. Wood char	10%
3. Coke	10%
4. Fireplace slag	5%
5. Vegetation chips	5%

SAMPLE NO. C210180-0023 (1829 – Pit D 76 - 90 cm)

QUALITATIVE ANALYSIS	SEMI-QUANTITATIVE ANALYSIS (error 5%)
1. Mineral gravel, sand material	90%
2. Coal soot	5%
3. Fireplace slag	5%
4. Coke	Traces
5. Wood char	Traces

CONCLUSIONS:

The above soil samples contained particulate material which may have originated from the following sources:

Foundry emissions: coke, graphite, magnetic iron fines, plates, spheres, coal soot, metallurgical slag

Coal piles: coal

Combustion products from a low efficiency furnace: wood char, coal soot, fireplace slag, fly ash

Environment: mineral gravel, sand, mud, clay, wood fibres and chips, vegetation fibres and chips

House: asphalt particles from roof shingles

Appendix D: Ontario Regulation 153/04 – Records of Site Condition

The ministry's soil, ground water, and sediment standards are for use under *Part XV.I* of the *Environmental Protection Act* and are referred to in *Ontario Regulation 153/04 Records of Site Condition (O. Reg. 153/04)*. These standards were specifically developed to assist landowners in the clean-up and redevelopment of contaminated sites. The environmental standards in *O. Reg. 153/04* are, however, sometimes used to interpret soil, sediment, and ground water quality outside of the purposes of the regulation. In these situations, sampling results that are elevated with respect to the *O. Reg. 153/04* standards do not necessarily indicate that remediation is required or that adverse effects will or have occurred. A qualified person should consider, on a site specific basis, whether or not there is potential for effects when using the *O. Reg. 153/04* standards to interpret soil, sediment, and ground water quality. This could include consideration of how the standards were developed, supplementary environmental sampling, an ecological and/or a human health risk assessment and/or a human health study.

O. Reg. 153/04 contains a series of Tables, each having criteria for soil, sediment, and ground water for various land-use categories (e.g., agricultural, residential, industrial). *Table 1* criteria reflect the upper estimate of typical background concentrations found in Ontario. Soil sampling results that are elevated relative to the ministry's background based (Table 1) soil standards indicates the possible presence of a contaminant source (either naturally occurring or anthropogenic in origin). *Tables 2* through *9* criteria are generic effects-based and relate to potable or non-potable ground water conditions. These standards were developed based on a number of assumptions and represent the lowest value from a table of "component" values established to protect different receptors (i.e., ecological receptors versus human health). The most sensitive of four main components (human health; leaching from soil to groundwater; vapour migration from soil to indoor air; and terrestrial ecological protection) is used to determine the soil Generic Site Condition Standards for each parameter. In some situations, the most sensitive component (i.e., the component that drives the standard) may not be the most relevant component for a particular site and/or for the purposes for which the standard is being used (e.g., the relevant receptor for a particular site may be human but the standard may have been selected based on the protection of plants). For additional details regarding the development of the ministry's generic soil standards, please refer to the following document: "Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario (MOE, 2011)" which can be found at www.ene.gov.on.ca.